

CLAIMS

What is claimed is:

1. A method for controlling nucleation sites during superabrasive particle synthesis, comprising the steps of:
 - 5 a) forming a raw material layer including a raw material;
 - b) forming a particulate catalyst layer adjacent the raw material layer to form a crystal growth layer, said particulate catalyst layer including a catalyst material; and
 - 10 c) placing crystalline seeds in a predetermined pattern at least partially in at least one of the catalyst layer and the raw material layer to form a growth precursor.
2. A method for controlling nucleation sites during superabrasive particle synthesis, comprising the steps of:
 - 15 a) forming a particulate crystal growth layer, including a substantially homogeneous mixture of raw material and catalyst material; and
 - b) placing crystalline seeds in a predetermined pattern at least partially in the particulate crystal growth layer to form a growth precursor.
- 20 3. The method of claim 1, wherein said catalyst layer consists essentially of catalyst material.
4. The method of claim 2, wherein said particulate crystal growth layer consists essentially of raw material and catalyst material.
- 25 5. The method of claim 1 or claim 2, wherein the superabrasive particle is diamond and the raw material is a carbon source.
6. The method of claim 5, wherein said catalyst material is a member selected
30 from the group consisting of Fe, Ni, Co, Mn, Cr, and alloys thereof.
7. The method of claim 6, wherein said catalyst material is an Fe-Ni alloy having about 65 wt% Fe and about 35 wt% Ni.

8. The method of claim 5, wherein said carbon source is graphite.
9. The method of claim 8, wherein said graphite has a degree of graphitization of
5 greater than 0.50.
10. The method of claim 9, wherein said graphite has a degree of graphitization of
from about 0.75 to about 1.
- 10 11. The method of claim 1 or claim 2, wherein the superabrasive particle is cubic
boron nitride and the raw material is a hexagonal boron nitride source.
12. The method of claim 11, wherein the catalyst material is a member selected
from the group consisting of alkali, alkali earth metal, and compounds thereof.
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13. The method of claim 1 or claim 2, wherein the crystalline seed is a member
selected from the group consisting of diamond seed, cBN seed, SiC seed, and
combinations thereof.
- 20 14. The method of claim 1, wherein the step of placing crystalline seeds includes
placing the crystalline seeds in the raw material layer and the crystalline seeds are
coated with a catalyst coating.
15. The method of claim 14, wherein said raw material layer is a particulate
25 source layer.
16. The method of claim 14, wherein said catalyst coating is a catalyst metal
selected from the group consisting of iron, nickel, cobalt, and alloys thereof.
- 30 17. The method of claim 1, wherein the step of placing crystalline seeds include
placing the crystalline seeds in the catalyst layer.

18. The method of claim 1, wherein the step of placing crystalline seeds substantially surrounds each crystalline seed with catalyst material.

19. The method of claim 18, wherein the step of placing crystalline seeds further
5 comprises pressing the crystalline seeds partially into the catalyst layer and then forming a second catalyst layer on the catalyst layer such that each crystalline seed is substantially surrounded by catalyst material.

20. The method of claim 18, wherein the step of placing crystalline seeds further
10 comprises pressing the crystalline seeds completely into the catalyst layer such that each crystalline seed is substantially surrounded by catalyst material.

21. The method of claim 2, wherein the step of placing crystalline seeds substantially surrounds each crystalline seed with catalyst material and raw material.
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22. The method of claim 1 or claim 2, further comprising the steps of repeating the steps of forming layers and placing crystalline seeds at least one additional time to form a multi-layered growth precursor.

20 23. The method of claim 1 or 2, further comprising the step of heating and pressing the growth precursor to a temperature and pressure sufficient for growth of superabrasive particles to produce grown superabrasive particles.

24. The method of claim 23, wherein the temperature is from about 1000 °C to
25 about 1300 °C and the pressure is from about 4 to about 7 GPa.

25. The method of claim 23, wherein the temperature is from about 10 °C to about 200 °C above a melting point of the catalyst.

30 26. The method of claim 23, wherein said crystalline seeds have an average diameter from about 0.05 to about 0.2 times an average diameter of the grown superabrasive particles.

27. The method of claim 1 or claim 2, wherein said crystalline seeds are from about 30 μm to about 500 μm in diameter.

28. The method of claim 1 or claim 2, wherein the predetermined pattern places
5 crystalline seeds a distance of from about 400 μm to about 900 μm apart.

29. The method of claim 28, wherein the superabrasive particles have a particle size from about 100 μm to about 2 mm.

10 30. The method of claim 29, wherein the superabrasive particles have a particle size from about 210 μm to about 1 mm.

31. The method of claim 1 or claim 2, wherein the step of placing crystalline seeds includes:

- 15 a) placing a template having a pattern of apertures upon a surface of the crystal growth layer, each of said apertures being configured to receive a single crystalline seed;
- b) filling the apertures of said template with the crystalline seeds; and
- c) pressing said crystalline seeds at least partially into the crystal growth
20 layer.

32. The method of claim 1 or claim 2, wherein the step of placing crystalline seeds includes:

- a) providing a transfer sheet having an adhesive layer thereon;
- 25 b) placing a template having a pattern of apertures upon the adhesive layer, each of said apertures being configured to receive a single crystalline seed;
- c) filling the apertures of said template with the crystalline seeds;
- d) placing the transfer sheet against a surface of the crystal growth layer; and
30 e) pressing said crystalline seeds at least partially into the crystal growth layer.

33. The method of claim 1 or claim 2, wherein the step of placing crystalline seeds includes:

- a) providing a vacuum chuck configured with a pattern of apertures;
- b) pulling a vacuum through the apertures and engaging a single crystalline seed in each aperture;
- c) depositing the crystalline seeds on a surface of the crystal growth layer such that the crystalline seeds are arranged in a predetermined pattern corresponding to the pattern of apertures; and
- d) pressing said crystalline seeds at least partially into the crystal growth layer.

34. A growth precursor, comprising at least one crystal growth layer having a raw material layer and a particulate catalyst layer, said catalyst layer having a plurality of crystalline seeds placed in a predetermined pattern.

35. A growth precursor, comprising at least one crystal growth layer having a substantially homogeneous mixture of particulate raw material and particulate catalyst material, said crystal growth layer having a plurality of crystalline seeds placed in a predetermined pattern.

36. The precursor of claim 34 or claim 35, comprising from 3 to 10 crystal growth layers.

37. The precursor of claim 34 or claim 35, wherein said raw material is a carbon source.

38. The precursor of claim 37, wherein said catalyst material is a member selected from the group consisting of Fe, Ni, Co, Mn, Cr, and alloys thereof.

39. The precursor of claim 37, wherein said carbon source comprises graphite having a degree of graphitization of greater than 0.50.

40. The precursor of claim 34 or claim 35, wherein said raw material is a hexagonal boron nitride source.

41. The precursor of claim 40, wherein said catalyst material is a member selected
5 from the group consisting of alkali, alkali earth metal, and compounds thereof.

42. The precursor of claim 34 or claim 35, wherein the crystalline seed is a member selected from the group consisting of diamond seed, cBN seed, SiC seed, and combinations thereof.